Class – IX (Science)

Chapter – Journey Inside the Atom

Back Exercise Solution

1. **Choose the correct options and explain the reason for the correct and incorrect options in the context of Ernest Rutherford's gold foil experiment:**

(i) The experiment clearly showed the existence of neutrons in the nucleus.
(ii) The results disproved the plum pudding model and led to the idea of a nucleus at the centre of the atom.
(iii) The large deflection of a few alpha particles indicated that most of the mass of the atom and positive charge are packed into a tiny centre.
(iv) The way alpha particles were deflected showed that electrons move around the nucleus.

Solution:
Rutherford's gold foil experiment
Correct options: (ii) and (iii)
(i) Incorrect:
Rutherford's experiment did not show the existence of neutrons. Neutrons were discovered later by James Chadwick.
(ii) Correct:
The experiment disproved Thomson's plum pudding model and led to the idea of a small, dense, positively charged nucleus.
(iii) Correct:
Large deflection of a few alpha particles proved that most of the atom's mass and positive charge are concentrated in a tiny centre.
(iv) Incorrect:
The experiment did not show that electrons move around the nucleus.

2. Which of the following statements are correct or incorrect according to the Bohr's atomic model? Give a reason for each statement.

(i) Electrons lose energy while moving in fixed orbits and slowly fall into the nucleus.
(ii) Electrons can exist anywhere around the nucleus with no fixed energy.
(iii) Electrons revolve around the nucleus in orbits of fixed energy without losing energy.
(iv) Electrons can be found between energy levels as they move around the nucleus.

Solution:

Bohr's atomic model

(i) Incorrect:
According to Bohr, electrons do not lose energy while revolving in fixed orbits.
(ii) Incorrect:
Electrons cannot exist anywhere around the nucleus. They stay in fixed energy levels.
(iii) Correct:
Electrons revolve around the nucleus in orbits of fixed energy without losing energy.
(iv) Incorrect:
Electrons are not found between energy levels.

3. The composition of the nuclei of three atomic species X, Y, and Z are given as follows:

	X	**Y**	**Z**
Number of protons	**18**	**17**	**17**
Number of neutrons	**19**	**18**	**20**

Explain the relation between the following:
(i) Y and Z
(ii) Z and X

Solution:
Relation between X, Y and Z

X = 18 protons, 19 neutrons
Y = 17 protons, 18 neutrons
Z = 17 protons, 20 neutrons

(i) Y and Z:
They have the same atomic number but different mass numbers, so they are isotopes.

(ii) Z and X:
They have the same mass number but different atomic numbers, so they are isobars.

4. What conclusion did Rutherford draw about the position and characteristics of the atom's positively charged part based on the few alpha particles that bounced back or were deflected at large angles in the gold foil experiment?

Solution:

Rutherford's conclusion

Rutherford concluded that atoms contain a tiny, dense, positively charged nucleus at the centre. Alpha particles that bounced back came very close to this positively charged nucleus and were strongly repelled.

5. Explain and arrange the following statements in the correct chronological order to show how atomic models have evolved over time.
(i) Bohr's model proposed that electrons move in fixed orbits around the nucleus, each with a definite energy.
(ii) Thomson's model depicted the atom as a 'plum pudding' with electrons embedded in a sphere of positive charge.
(iii) Rutherford's model proposed that atoms have a dense central nucleus.
(iv) Dalton's model described atoms as indivisible particles.

Solution:
Brief explanation:

1. **Dalton's model (iv):**
   Dalton stated that atoms are tiny, indivisible particles. This was the earliest atomic theory.
2. **Thomson's model (ii):**
   After discovering electrons, Thomson proposed the "plum pudding model," where electrons are embedded in a positively charged sphere.
3. **Rutherford's model (iii):**
   Rutherford's gold foil experiment showed that atoms have a small, dense, positively charged nucleus at the centre.
4. **Bohr's model (i):**
   Bohr improved Rutherford's model by proposing that electrons move around the nucleus in fixed energy orbits.

Final Answer:

Dalton → Thomson → Rutherford → Bohr

6. **Electrons move around the nucleus in orbits. Why do they not fly away from the atom? Explain what keeps them attracted to the nucleus.**

   Solution:

Electrons do not fly away from the atom because they are attracted towards the positively charged nucleus by a strong **electrostatic force of attraction**.

Since electrons are negatively charged and the nucleus is positively charged, they remain bound to the atom. According to Bohr's model, electrons move in fixed energy orbits without losing energy, which keeps the atom stable.

7. **Assertion (A): The discovery of subatomic particles helped in understanding the atomic structure.**

   Reason (R): The number of electrons is equal to the number of protons in an atom.

   Choose the correct option:
   (i) Both A and R are true, and R is the correct explanation of A.

(ii) Both A and R are true, but R is not the correct explanation of A.
(iii) A is true, but R is false.
(iv) A is false, but R is true.

Solution:

Assertion–Reason

Correct option: (ii)

Both A and R are true, but R is not the correct explanation of A.

8. **Magnesium is essential for many biological processes, including muscle contraction. For an atom of magnesium with a mass number of 24 and atomic number 12, determine the number of:**
(i) protons
(ii) neutrons
(iii) electrons
Also illustrate the arrangement of electrons in a magnesium atom.

Solution:

Magnesium atom
Mass number = 24
Atomic number = 12
Protons = 12
Neutrons = 12
Electrons = 12
Electronic configuration = 2, 8, 2

9. **Find the following information for the elements shown in Fig. 8.17:**
(i) Name of the element
(ii) Symbol
(iii) Total number of electrons
(iv) Number of valence electrons
(v) Valency of the element
(vi) Number of protons
(vii) Atomic number
Solution:

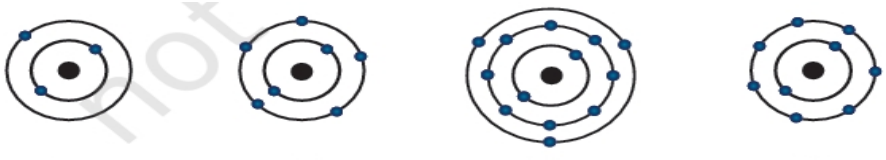

Fig. 8.17

(a) Lithium (Li)
Electrons = 3
Valence electrons = 1
Valency = 1
Atomic number = 3

(b) Nitrogen (N)
Electrons = 7
Valence electrons = 5
Valency = 3
Atomic number = 7

(c) Phosphorus (P)
Electrons = 15
Valence electrons = 5
Valency = 3
Atomic number = 15

(d) Neon (Ne)
Electrons = 10
Valence electrons = 8
Valency = 0
Atomic number = 10

10. Both Rutherford's and Bohr's models have electrons orbiting the nucleus. Why did Rutherford's model fail to explain atomic stability, while Bohr's model succeeded?

Solution:

Rutherford's Model	Bohr's Model
Electrons revolve around the nucleus like planets around the Sun.	Electrons revolve around the nucleus in fixed energy orbits or shells.
According to classical physics, moving electrons should continuously lose energy.	Electrons do not lose energy while moving in fixed orbits.
Electrons would spiral into the nucleus after losing energy.	Electrons remain stable in their fixed energy levels.
Could not explain why atoms are stable.	Successfully explained the stability of atoms.
Failed to explain atomic stability.	Explained atomic stability successfully.

Rutherford's model failed because it could not explain why electrons do not collapse into the nucleus. Bohr improved this model by introducing fixed energy orbits, which successfully explained the stability of atoms.

11 . An atom ^{70}X has 31 electrons. How many neutrons are there in its nucleus?

Solution:

Mass number (A) = 70
Number of electrons = 31

For a **neutral atom**:

Number of protons = Number of electrons

So,

Number of protons = 31

Atomic number is equal to the number of protons.

Therefore,

Atomic number (Z) = 31

Now,

Number of neutrons = Mass number – atomic number

Number of neutrons = 70 – 31

Number of neutrons = 39

Final Answer:

The atom ^{70}**X** has **39 neutrons** in its nucleus.

12. An atom has 79 protons and a mass number of 197. Calculate:
(i) the number of neutrons
(ii) the number of electrons

Solution:

Atom with 79 protons

Mass number = 197

Neutrons = 197 – 79 = 118
Electrons = 79

13. Complete table 8.5 :

Row	Atomic Number	Mass Number	Number of Neutrons	Number of Protons	Number of Electrons	Name of Element
1	**5**	6	**6**	5	5	Boron
2	14	**14**	7	7	**7**	**Nitrogen**
3	24	**24**	12	**12**	12	Magnesium
4	**15**	31	**16**	15	15	Phosphorus
5	1	1	**0**	1	1	Hydrogen

14. Aman was discussing the structure of atom with his classmates. During the discussion, he learnt that an element X has a mass number of 35 and contains 18 neutrons. Based on this information, answer the following questions:

(i) How many electrons and protons does element X have?
(ii) What is its atomic number?
(iii) Identify the element X.
(iv) Write its electronic configuration.
(v) How many valence electrons does it have?
(vi) What will the mass number be if two neutrons are added to its nucleus?
(vii) What will be the relation of X with the new atom?
Solution:

Element X

Mass number = 35
Neutrons = 18

Protons = 17
Electrons = 17
Atomic number = 17

Element = Chlorine
Electronic configuration = 2, 8, 7
Valence electrons = 7

If 2 neutrons are added:
New mass number = 37

The new atom will be an isotope of chlorine.

15. In an atom, there are 12 protons and 12 neutrons in the nucleus. Now, imagine that all the electrons are replaced with some hypothetical particles that have the same charge as electrons but are 500 times heavier. What effect will this replacement have on the atom's:

(i) Atomic number
(ii) Atomic mass
(iii) Mass number
(iv) Overall charge

Solution:

Protons = 12
Neutrons = 12
Electrons = 12

Electrons are replaced by particles having the same negative charge, but 500 times heavier mass.

Part	Effect	Reason
(i) Atomic number	Remains 12	Atomic number depends only on the number of protons.
(ii) Atomic mass	Increases slightly	New particles are much heavier than electrons, so total atomic mass increases.
(iii) Mass number	Remains 24	Mass number = protons + neutrons = 12 + 12 = 24. Electrons are not counted.
(iv) Overall charge	Remains zero / neutral	New particles have the same negative charge as electrons, so 12 positive protons and 12 negative particles balance each other.

Final Answer:

Atomic number = 12
Atomic mass = increases slightly
Mass number = 24
Overall charge = neutral